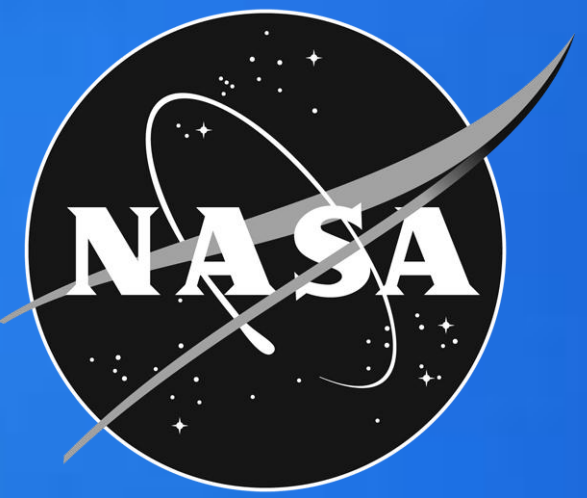


Commercial Modular Aero-Propulsion System Simulation 40k

C-MAPSS40k Version 2

NASA Glenn Research Center

National Aeronautics and
Space Administration



Description

The Commercial Modular Aero-Propulsion System Simulation 40k (C-MAPSS40k) is a MATLAB/Simulink (The MathWorks Inc., Natick, MA) based simulation that represents in-flight engine dynamics. It provides easy access to internal variables and control and health information. The user can specify throttle input commands, altitude and Mach number trajectories, and component health condition. C-MAPSS40k was specifically designed as a testbed for the development and validation of control and diagnostics algorithms.

Technical Approach

- A detailed physics-based Component Level Model (CLM) of a commercial turbofan engine was scaled to the 30-40k thrust class
- The CLM was tuned so that its dynamic response reflects the characteristics of flight test data captured during transient operation from a highly instrumented engine
- A baseline controller, representative of a typical industry architecture, was developed and tuned to meet all relevant FAA and airframe manufacturer's specifications
- Compiled code is used to improve simulation execution speed to faster than real-time

Features of C-MAPSS40k

- Transient and steady state performance is representative of that of engines in the 30-40k thrust class
- Capable of executing arbitrarily complex flight profiles
- Can develop linear models at fixed operating points
- Detailed surge margin calculation for steady state and transient operation
- Executes faster than real-time on typical PC
- Realistic controller represents typical architecture found on commercial turbofan engines
- Requires no extra MATLAB/Simulink toolboxes
- User-friendly Graphical User Interface
- Can simulate typical engine deterioration as well as engine component faults
- Works with all versions of MATLAB from 2007b

Improvements in Version 2

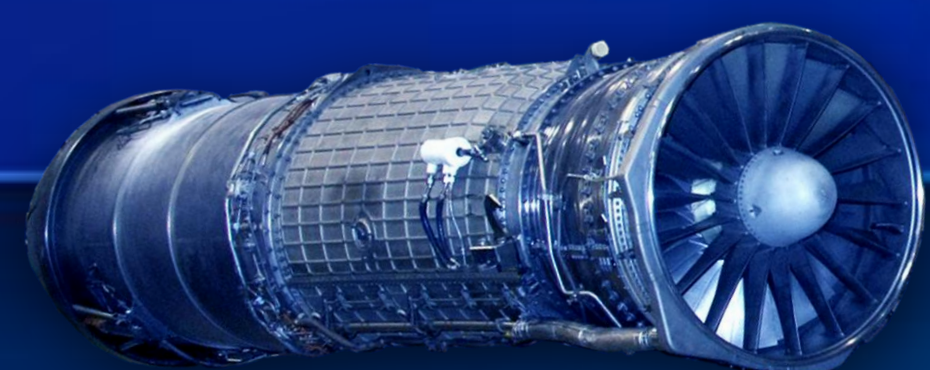
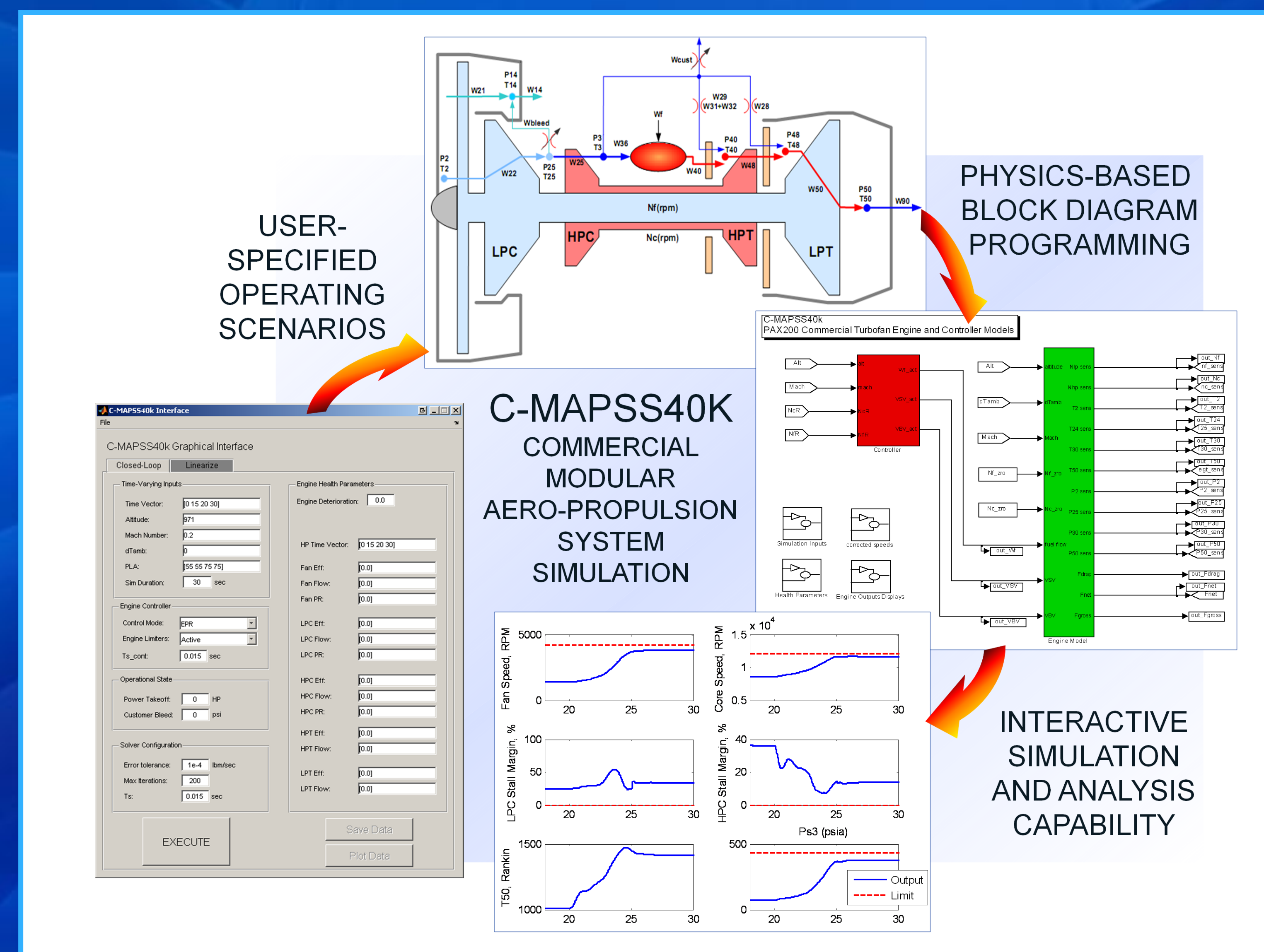
- Stall margin calculation modified to account for variations due to off-schedule actuator operation
- User can generate linear models from the actual Simulink code rather than a stored C-code version of simulation; this allows the linear model to account for the user's custom changes to the nonlinear model
- Control system modified to use T2 and P2 rather than Alt and MN
- Controller limit logic updated
- T50 limiter added for custom applications
- Simulation outputs consolidated into a single data structure to facilitate multiple instances of the engine running in parallel
- Robustness of simulation improved

Request the Software

Free download available to U.S. citizens from the NASA GRC Software Repository:
<https://technology.grc.nasa.gov/software/>

More Information

- R. May, et al., "Commercial Modular Aero-Propulsion System Simulation 40k (C-MAPSS40k) User's Guide," NASA TM-2010-216831 (Update in review)
- R. May, et al., "A High-Fidelity Simulation of a Generic Commercial Aircraft Engine and Controller," AIAA-2010-6630, JPC, July 2010
- J. Csank, et al., "Control Design for a Generic Commercial Aircraft Engine," AIAA-2010-6629, JPC, July 2010



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